CROSSLINKED TINTED POLYMERS

The invention relates to a novel process for the production of mouldings, in particular contact lenses, in which a crosslinkable tinted polymer is crosslinked in solution, and to mouldings, in particular contact lenses, which are obtainable by this process.

The present invention also relates to novel crosslinkable tinted polymers comprising units containing a crosslinkable group and units containing a covalently bonded reactive dye radical which can be employed in the novel process, in particular those based on starting polymers containing functional groups, for example hydroxyl groups, on the polymer chain or functional groups, for example imino groups, in the polymer chain or functional groups bonded to the polymer skeleton via a bridge, where these functional groups allow covalent bonds to compounds containing a crosslinkable modifier group or another modifier group. These starting polymers are, in particular, polyhydroxyl compounds having a 1,2-and/or 1,3-diol structure, such as polyvinyl alcohol, or hydrolysed copolymers of vinyl acetate, for example copolymers with vinyl chloride, N-vinylpyrrolidone, etc. The invention furthermore relates to crosslinked novel polymers, either homopolymers or copolymers, made from these novel crosslinkable tinted polymers, to a process for the preparation of the novel crosslinkable tinted polymers and the homopolymers and copolymers obtainable therefrom, to mouldings made from said homopolymers or copolymers, in particular contact lenses made from these homopolymers or copolymers, and to a process for the production of contact lenses using the said homopolymers or copolymers.

Tinted or coloured contact lenses are known. Conventional contact lenses are only tinted or coloured after their final shaping by subsequent application of a reactive dye tinting taking place on the surface (for example in accordance with EP-A-0 388 357 and EP-A-0 072 353). This tinting process is followed by at least a neutralization step, an extraction step and a rinsing step, ie the completion of the lenses takes a considerable time.

One of the objects of the present invention was substantially to reduce or completely to eliminate these time-consuming production steps.

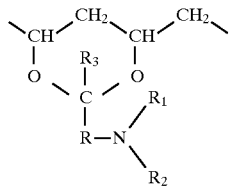
This object is achieved in accordance with the invention on the one hand by the provision of novel crosslinkable tinted polymers comprising units containing a crosslinkable group and units containing a covalently bonded reactive dye radical, and on the other hand by crosslinking these crosslinkable tinted polymers directly, preferably in water, in particular by photocrosslinking, very rapidly to give crosslinked tinted polymers, in particular tinted contact lenses.

The invention thus consists in, in particular, carrying out the tinting of contact lenses before their final shaping. This overcomes all disadvantages known from the prior art mentioned, and in particular the time-consuming neutralization steps and extraction steps for completion of the lenses are eliminated.

The present invention relates, in particular, to starting polymers (homopolymers and copolymers) which contain a functional group on the polymer chain, for example a hydroxyl (aliphatic or phenolic), amino, amido, thio or carboxyl group, or functional derivatives thereof, or which contain a functional group in the polymer chain, for example an imino group, which can then react directly with a reactive dye molecule or can react with a group which contains a crosslinkable group or a group containing a reactive dye.

Besides the reactive dye molecule and the crosslinkable group, the polymer backbone can, if desired, also contain further modifiers.

The starting polymers are preferably derivatives of polyvinyl alcohol or copolymers of vinyl alcohol which contain a 1,3-diol skeleton. The crosslinkable group and the group containing a reactive dye radical can be bonded to the polymer skeleton in various ways, for example, in the case of a group containing a crosslinkable group, through a certain percentage of the 1,3-diol units being modified to give a 1,3-dioxane which contains a crosslinkable radical in the 2-position. The crosslinkable radical is, in particular, an aminoalkyl radical with a crosslinkable group bonded to its nitrogen atom. This is preferably a derivative of a polyvinyl alcohol having a mean molecular weight of at least about 2000 which comprises from about 0.5 to about 80%, based on the number of hydroxyl groups in the polyvinyl alcohol, of units of the formula I



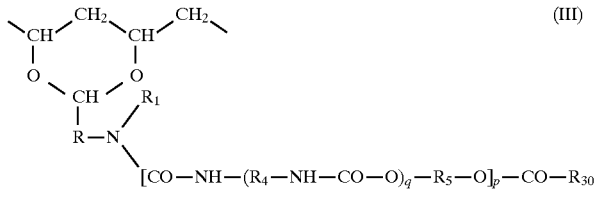
(I)

in which R is alkylene having up to 12 carbon atoms, R_1 is hydrogen or lower alkyl, and R_2 is an olefinically unsaturated, electron-withdrawing, copolymerizable radical, preferably having up to 25 carbon atoms, and R_3 is hydrogen, a C_1C_6alkyl group or a cycloalkyl group. R_2 is, for example, an olefinically unsaturated acyl radical of the formula R_{30}—CO—, in which R_{30} is an olefinically unsaturated, copolymerizable radical having 2 to 24 carbon atoms, preferably having 2 to 8 carbon atoms, particularly preferably having 2 to 4 carbon atoms. In another embodiment, the radical R_2 is a radical of the formula II

$$—CO—NH—(R_4—NH—CO—O)_q—R_5—O—CO—R_{30} \quad (II)$$

in which q is zero or one, and R_4 and R_5, independently of one another, are lower alkylene having 2 to 8 carbon atoms, arylene having 6 to 12 carbon atoms, a saturated bivalent cycloaliphatic group having 6 to 10 carbon atoms, arylenealkylene or alkylenearylene having 7 to 14 carbon atoms or arylenealkylenearylene having 13 to 16 carbon atoms, and in which R_{30} is as defined above.

The crosslinkable polymer is therefore in particular a derivative of a polyvinyl alcohol having a molecular weight of at least about 2000 which comprises units of the formula III



(III)

in which R is lower alkylene, R_1 is hydrogen or lower alkyl, p has the value zero or one, q has the value zero or one, R_{30} is an olefinically unsaturated, copolymerizable radical having 2 to 8 carbon atoms, and R_4 and R_5, independently of one another, are lower alkylene having 2 to 8 carbon atoms, arylene having 6 to 12 carbon atoms, a saturated bivalent cycloaliphatic group having 6 to 10 carbon atoms, arylenealkylene or alkylenearylene having 7 to 14 carbon atoms or arylenealkylenearylene having 13 to 16 carbon atoms.